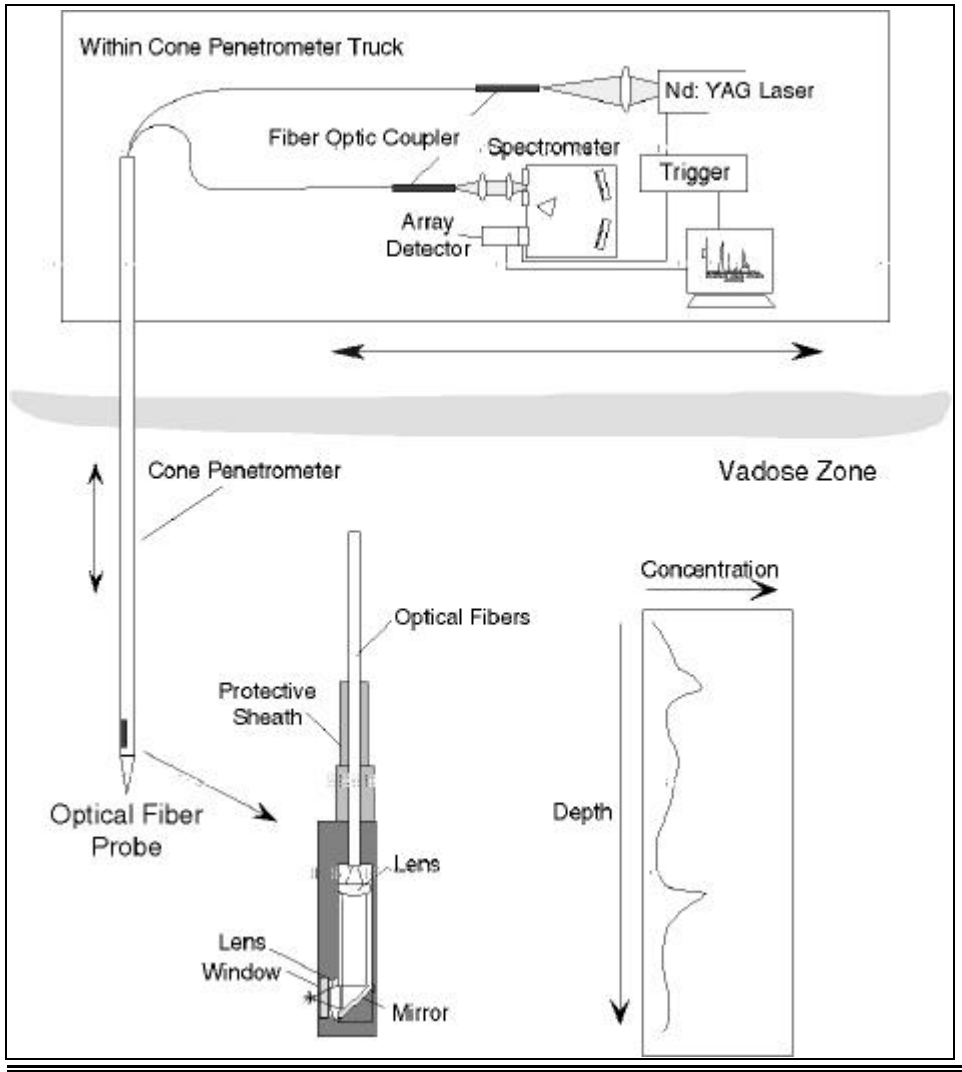
Fiber Optic/Cone Penetrometer System for Subsurface Heavy Metals Detection

Developer: Science & Engineering Associates, Inc.
Contract Number: DE-AR21-95MC32089
Crosscutting Area: CMST

Subsurface Contaminants FOCUS AREA

Problem:

The characterization of contaminated soils for heavy metals can be expensive and time consuming due to the high number of samples required to effectively evaluate a site and the utilization of laboratory chemical analysis techniques. The present laboratory methods of evaluating environmental samples offer high sensitivity and the ability to evaluate multiple chemicals, but the time and cost associated with such methods often limit their effectiveness. There exists a requirement for an economically feasible, real-time, in situ system for the mapping of heavy metal contaminated soils.



Solution:

Develop and demonstrate an integrated fiber optic laser spectroscopic sensor with a cone penetrometer system that can analyze the heavy metal-content of the subsurface in-situ.

Benefits:

- Penetrometer deployment of the sensor will enable high-resolution mapping of the subsurface.
- Real-time, in situ analysis will allow for on-site identification of the location of heavy-metal contamination, thus streamlining the remediation process and reducing costs.
- Applicable to a variety of sites due to multiple-analyte detection capability.

Technology:

The purpose of this project is to develop an integrated fiber optic sensor/cone penetrometer system to

analyze the heavy-metals content of the subsurface. This site characterization tool will use the penetrometer to deploy an optical fiber chemical sensor which is based on laser induced breakdown spectroscopy (LIBS).

In LIBS, a pulse from a high-energy laser, typically a Nd:YAG operating at 1.06 m, is delivered to the soil sample via an optical fiber. The soil sample will absorb the laser pulse, heat rapidly, reduce to elemental form, and become electronically excited. When the input pulse is removed, the excited electrons drop to lower energy levels with the emission of characteristic photons. The plasma emission is returned from the sample via a second fiber. Elemental analysis is conducted by observation of the wavelength and intensities of the emission lines, which will depend upon the type and amount of material present within the plasma. This technique has shown to be an effective method for the quantitative analysis of contaminants in soils.

There are several significant challenges associated with the integration of the LIBS sensor and cone penetrometer. One challenge is to design an effective means of optically accessing the soil via the fiber probe in the penetrometer. A second challenge is to develop the fiber probe system such that the resultant emission signal is adequate for quantitative analysis. These issues will be addressed during this project by investigating both hardware and software solutions.

Contacts:

Science & Engineering Associates is active in the area of fiber optic sensors and high-power laser delivery via optical fibers. For information on this project, the contractor contact is:

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